Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C.

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

In the Matter of	)	
	)	
Rulemaking to Amend Parts 1,2, 21, and 25	)	
of the Commission's Rules to Redesignate	)	CC Docket No. 92-297
the 27.5 - 29.5 GHz Frequency Band, to	)	
Reallocate the 29.5 - 30.0 GHz Frequency	)	
Band, to Establish Rules and Policies for	)	
Local Multipoint Distribution Service and	)	
for Fixed Satellite Services	)	

Comments of Hewlett-Packard Company

On Third Notice of Proposed Rulemaking
and
Supplemental Tentative Decision

I. INTRODUCTION

Hewlett-Packard Company ("HP") is pleased to submit comments of conditional support for the Federal Communications Commission's ("FCC" or "Commission") 28 GHz spectrum band sharing proposal contained in the above-referenced proceeding. We recognize the tremendous challenges the Commission has faced in finding an equitable band sharing approach for the valuable 28 GHz spectrum, and we commend the Commission's continued efforts to this end.

As a $25 billion global company that manufactures some 20,000 products, potentially including equipment for local multipoint distribution services ("LMDS"), HP believes that there are three major issues that need to be revised in the Commission's latest proposal in order to make efficient use of the spectrum, and these are described in the following comments. There are also several areas in which clarification is needed. This proceeding is critically important to companies, like HP, that will manufacture LMDS equipment and provide other services. We are committed to working with the Commission and other interested parties so that resolution of this docket can occur in a timely manner.

II. THE PROPOSED EQUIVALENT ISOTROPICALLY RADIATED POWER ("EIRP") LIMIT OF -52 DBW/HZ IS NOT SUFFICIENT FOR THE POINT-TO-POINT, SUBSCRIBER UNIT TO HUB STATION UPSTREAM LINK, AND SHOULD BE INCREASED TO AT LEAST -30 DBW/HZ.

The FCC has proposed allocation of 850 MHz between 27.5-28.35 GHz for both downstream and upstream LMDS uses. While the FCC proposal to limit EIRP to -52 dBW/Hz in the 27.5 to 28.35 GHz band is adequate for Local Multipoint Distribution Hub Stations which utilize low gain antennas to reach a large number of LMDS subscriber stations, it is seriously inadequate to provide an upstream link with sufficient performance margins to meet the projected two-way applications for LMDS. We believe that at least -30 dBW/Hz is necessary for the subscriber to hub station point-to-point link. This is significantly less than the current power density limits of -18 dBW/Hz. Increasing the EIRP to -30 dBW/Hz would not cause intersystem interference because it is a point-to-point link, and therefore, it is a highly directed, focused beam. It should be noted that even this increased power limit does not reflect the needs of systems that may be proposed for longer distances, nor does it allow for advances in 28 GHz components that will enable higher power limits in the future These higher power levels will be required to enable LMDS systems to either extend their range or to use higher modulation efficiency methods in order to accommodate additional subscribers in the allocated spectrum. See Appendix A for a link budget analysis for a 2 km link.

III. SUBSCRIBER UNITS MUST BE ALLOWED TO TRANSMIT IN THE 150 MHZ BAND IN ORDER FOR LMDS TO BE COMPETITIVE. FURTHERMORE, LMDS AND MSS UPLINKS CAN COEXIST IN THIS BAND WITHOUT ADVERSE INTERFERENCE.

HP supports the Commission's proposal to split the 1 GHz spectrum for LMDS uses into 850 MHz at 27.5-28.35 GHz and 150 MHz at 29.10-29.25. However, we are seriously concerned about the Commission's proposal to limit the use of the 29.10-29.25 GHz band to hub-to-hub transmissions. Such a plan would greatly reduce the utility of this band and the advantages gained by having a split spectrum available for LMDS if transmitters are not allowed to operate from subscriber locations in this band. If, on the other hand, the 29.10-29.25 GHz band could be used for the point-to-point upstream link from the subscriber unit to the hub station, the filter isolation requirements in both the hub station equipment and the subscriber unit are greatly simplified. This reduces both complexity and cost. If, however, the upstream link is constrained to use the 850 MHz band from 27.5 to 28.35 GHz it would significantly reduce the efficient use of that spectrum due to the guardbands necessary to separate the upstream and downstream channels.

We recognize the Commission's concern regarding the possible interference with Motorola Inc.'s ("Motorola") proposed use of the 29.1-29.25 GHz band for satellite services. The analysis for HP's proposed digital LMDS equipment confirms an earlier analysis by Texas Instruments ("TI") that concludes that subscriber unit transmitters will not cause harmful interference to the Iridium satellite receivers (see Appendix B). Although the analysis results in a relative EIRP density at elevations above the horizon that are consistent with Table 2 in proposed new rule section 21.1021, it exceeds the limits set forth in Table 1 of new proposed rule Section 21.1020 for 0 degree elevation by approximately 1 dB for the high density household scenario. We question the need for a specification for spectral area density limit at 0 degrees elevation, however we support a spectral area density limit for elevations above the horizon. It has been our experience that at zero degree elevation for rooftop antennas the path loss exceeds the free space path loss due to diffraction and ground reflections, and at distances of more than 2-3 km one can expect an <u>excess</u> loss of at least 20 dB per decade. This significantly reduces the possibility of interference to a satellite receiver on the horizon. The analysis in Appendix B assumes an elevation of 7.5 degrees

HP also recognizes that the analysis is based on several assumptions about housing densities, percent suitable for LMDS, take, demand, etc. For that reason, different people might arrive at different conclusions for the same equipment. This being the case, it can be assumed that comments in response to this issue will result in somewhat different recommendations, however we expect that the Commission is anxious to adopt a "standard" method of analysis to determine the potential for interference in this band. To help achieve this goal, HP is committed to working with interested parties, under the Commission's direction, to resolve the differences and develop a consensus approach to evaluate the potential for satellite interference from LMDS subscriber units.

MSS ground terminals will not interfere with LMDS hub stations as long as hub station antenna heights are relatively modest (i.e., less than 20 meters), and minimum distances between MSS ground terminals and LMDS hubs are at least 5 km. It has been our experience that significant excess path loss can be expected over this distance due to diffraction, ground reflections and the presence of obstacles. For these reasons, along with the fact that there will be relatively few MSS ground terminals, potential interference issues should be able to be dealt with on a case-by-case basis and, where necessary, mitigation techniques employed.

IV. IT IS ESSENTIAL THAT ONE OPERATOR BE ALLOWED TO OBTAIN A LICENSE FOR THE ENTIRE 1 GHZ OF SPECTRUM IN ORDER TO ENABLE LMDS TO BE COMPETITIVE WITH ALTERNATIVE TECHNOLOGIES FOR PROVIDING SERVICES.

HP strongly urges the Commission to develop an LMDS licensing plan that allows a single operator to obtain a license for the entire 1 GHz of spectrum. Subdividing the spectrum in order to issue licenses to multiple competing LMDS operators would significantly reduce the utility of the spectrum, and therefore, its value. The applications envisioned for this spectrum will be competing with other technologies, rather than with other LMDS operators, to provide a similar set of services, and if the spectrum available to any one operator was reduced, it is unlikely that potential LMDS operators would invest in it. Secondly, LMDS currently has technical requirements, such as robust modulation methods, that create natural challenges to competing with other technologies, such as hybrid fiber coax. Dividing the LMDS spectrum among two or more licensees would create a further obstacle for LMDS, and it is unlikely that LMDS could be a viable competitor to other, more mature, technologies.

It is quite possible that in major markets as many as three operators would be in competition for the same customers; the present local exchange carrier ("LEC"), the present local cable operator (each of these with an extension of their present wired network) and the eventual LMDS licensee. Although, not available today, we expect technology to develop in the future to the point where one could use more efficient modulation schemes thus improving the spectral efficiency of this band. Some of this additional capacity will be used to satisfy an expected increase in demand for services and for a growing number of customers. Unused capacity, however, could be sublet to other operators to provide other specialized services as suggested by the Commission in paragraph 80.

V. BUILDOUT REQUIREMENTS WOULD HAMPER DEPLOYMENT OF LMDS SYSTEMS AND SHOULD BE AVOIDED.

We agree with the Commission's intent on this issue, but encourage the Commission to evaluate other alternatives. The "Buildout" requirement has several drawbacks:

- Not all geographical areas within a license area (BTA in this case) will be suitable for LMDS due to the propagation characteristics (presence of obstacles, terrain, weather, etc.). If only 50% of the potential customers, for example, can be economically served by LMDS, it might be more realistic for the service provider to choose a different medium for reaching customers in that particular community.

- Some potential license holders might already have an existing broadband infrastructure in some portions of their license area. They would deploy LMDS elsewhere, but would not choose to "overlay" a satisfactory infrastructure that is already in place.

- Even in areas where LMDS is the technology of choice there will be households that will be shadowed by adjacent buildings, trees or other obstructions. If a buildout requirement is implemented a decision would need to be made as to how these "shadowed" homes count in determining if the license holder has met the buildout requirement.

To be entirely "fair" to the license holder it would be necessary to "discount" any buildout requirements in accordance with the above factors. This would make any objective measurement not only difficult to quantify, but also to enforce, and therefore, unrealistic.

We believe that it is unlikely that a LMDS licensee would invest a significant amount of capital to acquire the license and simply "sit" on it. Nevertheless, it is possible. We believe that these few exceptions could be dealt with on a case-by-case basis by the FCC.

VI. HP FAVORS THE REQUIREMENT THAT APPLICANTS COORDINATE FREQUENCIES AND POWER LEVELS AT LMDS SERVICE AREA BOUNDARIES IN LIEU OF FCC IMPOSED LIMITS.

We agree with the Commission's proposal to require applicants to coordinate frequencies among themselves at their service area boundaries The specification of a maximum power flux density would not accomplish very much since there are so many more variables associated with assuring that the two systems can operate at the geographic boundaries without interference. HP believes that it should be made mandatory that adjacent licensees be required to employ whatever tradeoffs are necessary to assure that both systems can coexist without interfering with each other at the service area boundaries.

VII. HP OPPOSES POLARIZATION RESTRICTIONS AS SUCH RESTRICTIONS POTENTIALLY LIMIT CREATIVITY AND THE DEVELOPMENT OF INNOVATIVE SYSTEM SOLUTIONS.

Given the conclusions reached in paragraph 120 of the FCC's proposal, which requires operators to coordinate among themselves at their service area boundaries, it would seem that adding the requirement that LMDS operators employ only orthogonally polarized signals is an unnecessary added restriction. Although not a significant limitation at present, it could limit creativity in future antenna designs that might employ other types of polarizations. Additionally, LMDS licensees may choose to use cross-polarization for one purpose within their network that may preclude its use to provide isolation between adjacent service areas.

VIII. CONCLUSION

HP believes that the Commission has done a laudable job of balancing the differing interests and concerns of interested parties in developing its proposal for sharing the 28 GHz band. We believe that there is a great deal of potential in making this valuable spectrum band available to the private sector in a way that is independent of the applications or the initial technologies used, while meeting the basic needs of fixed satellite service, mobile satellite service and local multipoint distribution service.

However, in summary, HP respectfully urges the Commission to accept the changes as described in the preceding comments so that the important 28 GHz band can be used fully and efficiently:

1. Increase EIRP limitations to at least -30 dBW/Hz in the band of 27.5-28.35 GHz.
2. Allow the 150 MHz band at 29.10-29.25 to be used for upstream links from subscriber locations.
3. A single LMDS operator should be allowed to obtain a license for the entire 1 GHz of spectrum.
4. There should not be any buildout requirements.
5. Applicants should coordinate frequency and power limits at LMDS service area boundaries.
6. Polarization restrictions should be avoided.

Respectfully submitted,

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Appendix A

Link budget for solid state LMDS system at 28 GHz

<u>Downstream (point-to-multipoint)</u>

1	Hub Station Amplifier Power at 1 dB Gain Compression (commercially available solid state amplifier)	1 watt (0 dBW)
2	Power Back-off (multi-channel QPSK)	6 dB
3	Hub Station TX Bandwidth per Amplifier	100 MHz
4	Hub Station Antenna Gain	15 dBi
5	EIRP	-71 dBW/Hz
6	FCC 3rd NPRM Proposal for EIRP limit	-52 dBW/Hz
7	Path Length	2 km
8	Free Space Path Loss	127.5 dB
9	Implementation Loss	3 dB
10	Subscriber Unit Antenna Gain	35 dBi
11	Subscriber Unit Receiver Noise Figure	6 dB
12	Receiver Thermal Noise (BW = 6 MHz)	-100.2 dBm
13	Carrier to Noise + Interference Ratio	28.5 dB
14	Required SNR for BER=10^{-6} for QPSK[(A1)] (no FEC)[(A2)]	14 dB
15	Link Margin	14.5 dB
16	Rainfall Attenuation - Region E for 99.9%	7 dB/km
17	Net Link Fade Margin	0.5 dB

[(A1)] It is anticipated that future technology will enable more spectral efficient modulation such as 16-QAM and 64-QAM. These require additional carrier to noise ratio approximately 6 and 12 dB respectively for a BER of 10^{-6}

[(A2)] Forward error correction, although, not assumed in this example can be used. This would result in an increased margin of 4-6 dB

Appendix A (cont.)

Link budget for solid state LMDS system at 28 GHz

Upstream (point-to-point)

1	Subscriber Unit TX Amplifier Power at 1 dB gain compression (commercially GaAs MMIC)	200 milliwatts (-7 dBW)
2	Power Back-off (single channel QPSK)	3 dB
3	Subscriber Unit TX Bandwidth	1 MHz
4	Subscriber Unit Antenna Gain	35 dBi
5	EIRP[(A4)]	-35 dBW/Hz
6	FCC 3rd NPRM Proposal for EIRP Limit	-52 dBW/Hz
7	Path Length	2 km
8	Free Space Path Loss	127.5 dB
9	Implementation Loss	3 dB
10	Hub Station Antenna Gain	15 dBi
11	Receiver Noise Figure	6 dB
12	Receiver Thermal Noise (BW = 12 MHz)	-97.2 dBm
13	Carrier to Noise + Interference Ratio	34.7 dB
14	Required SNR for BER=10^{-6} QPSK (no FEC)[(A3)]	14 dB
15	Link Margin	20.7 dB
16	Rainfall Attenuation - Region E for 99.9%	7 dB/km
17	Net Link Fade Margin	6.7 dB

[(A3)] Error correction is not planned for the upstream link due to the added complexity and cost to the subscriber unit.

[(A4)] EIRP for this example is 17 dB greater than proposed limit. Reducing the subscriber unit TX power to the proposed limit would eliminate most of the link margin which in this example may be satisfactory in the absence of rainfall in an ideal line-of-sight link. It would not, however, allow sufficient margin for any other path impairments such as trees, foliage, multipath, etc..

Appendix B

Analysis of HP LMDS Subscriber Unit Transmitters and Satellite Interference in 29.1-29.25 GHz Band

In the following analysis two different scenarios are used to evaluate the potential for interference from LMDS subscriber unit transmitters to the proposed Iridium satellite receivers in the 29.1-29.25 GHz band. Scenario 1 represents an area of high household density (8 million households in a 200 by 400 km "footprint") coupled with a very high expectation (75%) for the percentage of households suitable for LMDS.

Scenario 2 we feel is more representative of a typical BTA (4 million households in a 200 by 400 km footprint). In this scenario the percentage suitable for LMDS is assumed to be 50%, a number, based on our assessments of propagation characteristics, to be more realistic.

Although both scenarios result in a net EIRP Spectral Area Density at an elevation angle of 7.5 degrees that is within the limits proposed for Rule 21.1021, Table 2, Scenario 1 does not quite meet the limits proposed for Rule 21.1020, Table 1 for 0 degree elevation. Both scenarios, however, provide a carrier to interference ratio greater than 30 dB at the satellite receiver at an elevation of 7.5 degrees.

Appendix B-1

HP LMDS/Iridium Satellite Receiver Interference Analysis in 29.1-29.25 GHz Band

Scenario 1 100 HH/sq km 75% Suitable for LMDS 15.00% Peak Demand

Subscriber unit Tx at 23 dBW/MHz per FCC proposed section 21.1018

Satellite Receiver BW= 4.375 MHz

		Upstream					
		Subscriber to Hub					
		1	2	3	4	5	
		@Maximum Distance	@Minimum Distance	@ Half Max Distance	@Average Distance	Average EIRP	
1	**Frequency**	29.1	29.1	29.1	29.1		GHz
2	**Subscriber Tx Pwr/Channel**	18	18	18	18		dBm
3	**Tx Antenna Gain**	35	35	35	35		dBi
4	**Tx Bandwidth**	1	1	1	1		MHz
5	**Path Length**	2.0	0.10	1.0	1.4		kilometers
6	**EIRP/MHz**	23.0	-3.0	17.0	20.0		dBW
7	**Rainfall Allowance (Region D3, 99.9%)**	7.6	7.6	7.6	7.6		dB
8	**Net EIRP/Hz**	-44.6	-70.6	-50.6	-47.6		dBW/Hz
9	**FCC Proposal for clear air**	-37.0	-37.0	37.0	-37.0		dBW/Hz
10	**Hub to Subscriber Relative Antenna Height**	10.0	10.0	10.0	10.0		meters
11	**Look-Up Angle**	0.3	5.7	0.6	0.4		degrees
12	**Relative Antenna Gain @7.5 deg elevation**	-30.0	-3.0	-30.0	-30.0		dB
13	**Avg HH/Sq km**	100	100	100	100		
14	**% HH Suitable for LMDS**	75%	75%	75%	75%		
15	**Take**	50%	50%	50%	50%		
16	**Peak Demand**	15%	15%	15%	15%		
17	**% HH Pointing towards Satellite**	0.78%	0.78%	0.78%	0.78%		
18	**Load Factor**	15%	15%	15%	15%		
19	**Satellite Rcvr BW**	4.375	4.375	4.375	4.375		MHz
20	**Subscriber Tx Spectrum**	100.0	100.0	100.0	100.0		MHz
19	**% HH in Sat BW**	4.38%	4.38%	4.38%	4.38%		
20	**Area**	80000	80000	80000	80000		Sq km
21	**Total # HH in Footprint**	8000	20	2000	4000		Thousand Households
22	**Antenna Polarization Loss**	3	3	3	3		dB
23	**Net total LMDS EIRP @7.5 degrees**	-64.0	-89.0	-76.0	-70.0		dBW/Hz
24	**LMDS EIRP Spectral Area Density @7.5 deg**	-53.0	-78.1	-65.1	-59.0	-55.1	dBW/MHz/sq km
25	**FCC Rule 21.1021, Table 2 (Reg 3,4,5)**					-47.2	dBW/MHz/sq km
26	**LMDS EIRP Spectral Area Density @0 deg**					-25.1	dBW/MHz/sq km
27	**FCC Rule 21.1020, Table 1 (Reg 3,4,5)**					-26.0	dBW/MHz/sq km
28							
29	**Iridium Feeder Uplink**						
30	**Tx Pwr per Carrier**					-22.3	dBW
31	**BW per Carrier**					4.375	MHz
32	**Tx Antenna Gain**					56.3	dBi
33	**EIRP Density**					-32.4	dBW/Hz
34	**EIRP Density at 7.5 deg elev**					-21.1	dBW/Hz
35							
36	**C/I @ 7.5 degree elevation per Line 23**					34.0	dB
37	**C/I @ 7.5 degree elevation per Line 24**					26.1	dB

Notes:

Line 5 Four path lengths have been selected for analysis: 2.0 km, 0.1 km, 1.0 km and 1.4 km

Line 6,8 The use of adaptive power control or AGC has been assumed. therefore, only subscriber units at the cell periphery would be transmitting at the maximum EIRP.

Line 10,11 The relative height of the hub station antenna is planned to be no more than 10 meters above the subscriber unit antenna, therefore, "look-up' angles only become significant at relatively short path lengths.

Line 17 The antenna gain for the subscriber unit is assumed to be 35 dB with a 3 dB BW of approximately 2.8 degrees.

Line 18 "Load Factor" is used to identify the percentage of time the upstream link is being used for transmission, it is assumed that on a bidirectional link the downstream link will dominate the information flow.

Line 21 This is the total number of households in the 200 x 400 km "footprint" that fall within the cell radii of 2 km, 0.1 km, 1.0 and 1.4 km respectively.

Line 23,24 The values in column 1 (2.0 km path length) represents the total EIRP if all subscriber stations were transmitting at full clear air power. Column 2 represents the contributions from the close-in subscriber units with the high "look-up" angle. Column 3 represents a quarter of the households. Assuming half the households contribute an EIRP equal to column 1 minus 3 dB and a quarter of the households contribute the level indicated in column 3 while assuming that the remaining households contribute a negligible amount, yields an EIRP Spectral Power Density" as shown in column 5.

D. Gray, 09/06/95

Appendix B-2

HP LMDS/Iridium Satellite Receiver Interference Analysis in 29.1-29.25 GHz Band

Scenario 2 50 HH/sq km 50% Suitable for LMDS 15.00% Peak Demand

Subscriber unit Tx at 23 dBW/MHz per FCC proposed section 21.1018

Satellite Receiver BW= 4.375 MHz

		Upstream Subscriber to Hub 1 @Maximum Distance	2 @Minimum Distance	3 @ Half Max Distance	4 @Average Distance	5 Average EIRP	
1	**Frequency**	29.1	29.1	29.1	29.1		GHz
2	**Subscriber Tx Pwr/Channel**	18	18	18	18		dBm
3	**Tx Antenna Gain**	35	35	35	35		dBi
4	**Tx Bandwidth**	1	1	1	1		MHz
5	**Path Length**	2.0	0.10	1.0	1.4		kilometers
6	**EIRP/MHz**	23.0	-3.0	17.0	20.0		dBW
7	**Rainfall Allowance (Region D3, 99.9%)**	7.6	7.6	7.6	7.6		
8	**Net EIRP/Hz**	-44.6	-70.6	-50.6	-47.6		dBW/Hz
9	**FCC Proposal**	-37.0	-37.0	-37.0	-37.0		dBW/Hz
10	**Hub to Subscriber Relative Antenna Height**	10.0	10.0	10.0	10.0		meters
11	**Look-Up Angle**	0.3	5.7	0.6	0.4		degrees
12	**Relative Antenna Gain @7.5 deg elevation**	-30.0	-3.0	-30.0	-30.0		dB
13	**Avg HH/Sq km**	50	50	50	50		
14	**% HH Suitable for LMDS**	50%	50%	50%	50%		
15	**Take**	50%	50%	50%	50%		
16	**Peak Demand**	15%	15%	15%	15%		
17	**% HH Pointing towards Satellite**	0.78%	0.78%	0.78%	0.78%		
18	**Load Factor**	15%	15%	15%	15%		
19	**Satellite Rcvr BW**	4.375	4.375	4.375	4.375		MHz
20	**Subscriber Tx Spectrum**	100.0	100.0	100.0	100.0		MHz
19	**% HH in Sat BW**	4.38%	4.38%	4.38%	4.38%		
20	**Area**	80000	80000	80000	80000		Sq km
21	**Total # HH in Footprint**	4000	10	1000	1992		Thousand Households
22	**Antenna Polarization Loss**	3	3	3	3		dB
23	***Net total LMDS EIRP @7.5 degrees***	-68.8	-93.8	-80.8	-74.8		dBW/Hz
24	**LMDS EIRP Spectral Area Density @7.5 deg**	-57.8	-82.8	-69.8	-63.8	-59.8	dBW/MHz/sq km
25	**FCC Rule 21.1021, Table 2 (Reg 3,4,5)**					-47.2	dBW/MHz/sq km
26	**LMDS EIRP Spectral Area Density @0 deg**					-29.8	dBW/MHz/sq km
27	**FCC Rule 21.1020, Table 1 (Reg 3,4,5)**					-26.0	dBW/MHz/sq km
28							
29	**Iridium Feeder Uplink**						
30	**Tx Pwr per Carrier**					-22.3	dBW
31	**BW per Carrier**					4.375	MHz
32	**Tx Antenna Gain**					56.3	dBi
33	**EIRP Density**					-32.4	dBW/Hz
34	**EIRP Density at 7.5 deg elev**					-21.1	dBW/Hz
35							
36	**C/I @ 7.5 degree elevation per Line 23**					38.7	dB
37	**C/I @ 7.5 degree elevation per Line 24**					26.1	dB

Notes:

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